SE01 Documentation

For simplicity, we can think of 3-week intervals as a "month". Given N=6, we will have:

Month 0:
- no mice

Month 1:
- receive pair 1

Total: 1

Month 2:
- pair 1 mates

Total: 1

Month 3:
- pair 2 born (from pair 1)
- pair 1 mates

Total: 2

Month 4:
- pair 3 born (from pair 1)
- pair 1 mates
- pair 2 mates

Total: 3

Month 5:
- pair 4 born (from pair 1)
- pair 5 born (from pair 2)
- pair 1 mates
- pair 2 mates
- pair 3 mates

Total: 5

Month 6:
- pair 6 born (from pair 1)
- pair 7 born (from pair 2)
- pair 8 born (from pair 3)
- pair 1 mates
- pair 2 mates
- pair 3 mates
- pair 4 mates
- pair 5 mates

Total: 8

At N=6, we can notice a pattern arise:
no. of newborn = no. of pairs mating in the previous month
no. of mating = total no. of pairs in the previous month
Total pairs = no. of newborn + no. of mating

Extending for larger N in tabular form:

	"Month"												
	0	1	2	3	4	5	6	7	8	9	10	11	12
# of newborns	0	1	0	1	1	2	3	5	8	13	21	34	55
# of mating	0	0	1	1	2	3	5	8	13	21	34	55	89
Total	**0**	**1**	**1**	**2**	**3**	**5**	**8**	**13**	**21**	**34**	**55**	**89**	**144**

We can see that to compute the total pairs (f_n), we need to add the previous 2 previous totals ($f_{n-1} + f_{n-2}$). This sequence is exactly the Fibonacci sequence with the formula to find the nth term given by: $f_n = f_{n-1} + f_{n-2}$

Common algorithms to solve this would be using the iterative approach and recursion. But recursion is slow and iterative approach is O(n) at best. I used an implementation that will use direct computation using Binet's formula. Given by:

$$F_N = \frac{1}{\sqrt{5}}\left(\left(\frac{1+\sqrt{5}}{2}\right)^N - \left(\frac{1-\sqrt{5}}{2}\right)^N\right)$$

With no loops and need for recursion, the main breedingSimulator function (below) will only have a time complexity of O(1).